Partnered Pavement Research Center* - Road Map for Research (July 2007 *draft*)
Aligned with Pavement Program Steering Committee's Research Priorities and Objectives

***PPRC is a contract between the University of California Pavement Research Center (UCPRC) and the Division of Research and Innovation (DRI)**

Outcome: Policies and business practices that preserve and enhance California's pavement resources and investments through:

1. Improved delivery of pavement projects and services by Caltrans through new and improved methods and specifications
2. Optimized pavement performance and lower life cycle costs of pavement
3. Finding ways to design and build pavements with longer service lives to reduce congestion from recurring maintenance and rehabilitation
4. Finding ways through pavement research to make the transportation system in California the safest in the nation for travelers and workers through smoother pavements and more efficient maintenance and construction

Research Areas & Problem Statements								
	1. Pavement Management System	2. Smoothness	3. Preservation	4. Quiet Pavements	5. Construction Practices	6. Mechanistic-Empirical Design	7. Long Life Pavements	8. Recycling
Problem Statements	Problem #1: Information and data on the pavement infrastructure and highway network within California are not readily accessible or available to all possible end users.	Problem #2: Perception by the public that pavements as currently constructed and maintained within California provides unacceptable poor ride quality.	Problem #3: Pavement preservation techniques are not well understood within the transportation industry and state-of-the-art standards are nonexistent.	Problem #4: Perception by the public and FHWA that pavements as currently constructed and maintained within California result in unacceptable levels of noise.	Problem #5: Highway networks have reached near capacity and construction activities have increasingly negative impacts on the traveling public. Ways to increase construction efficiency and decrease time of lane closures need to be investigated.	Problem #6: With the advent of computers and algorithms it is possible to develop a more scientific approach to the design and analysis of pavement performance and to accurately predict the life of pavements and to determine as well the associated life cycle cost.	Problem #7: Congestion, increased travel times, and accidents associated with frequent construction and maintenance activities have become more prevalent with increases in population.	Problem #8: High quality sources of materials for constructing pavements are becoming more and more scarce relative to the location of construction projects. The scarcity of materials has created a need to find ways of reusing or recycling sound, in-place materials.
Overview - PPSC Objectives	Develop the ability to track pavement structural sections, related pavement performance, and pavement innovations over time by creating an Enterprise Pavement Management System.	Smoother pavements and higher ride quality.	Pavement preservation techniques, guides, and decision trees and the development of a center of excellence for training and research.	New and better maintained pavements that produce decreased levels of noise.	Faster construction capabilities through prefabrication, new techniques, new materials, composite pavements, and software.	Mechanistic-Empirical (ME) software applications that can be integrated within an enterprise-wide Pavement Management System.	Proven structural designs and construction practices that result in significantly increased service life of pavements.	Proven techniques of recycling in-place materials and a well trained and equipped industry workforce.
Recently Completed Research and Ongoing Projects	**Status:** • This objective will be coordinated with PPSC objectives 2 thru 8. • **PMS project:** At the direction of the Directorate the State Pavement Program Manager (SPPM) has prepared an action plan to build a first generation pavement management system (PMS). **UCPRC Work:** • **Pilot Project for Fixed Segmentation of the avement Network.** Report completed by UCPRC in 2006. Determined the feasibility of defining fixed highway network segments and determined data collection & database operations requirements. Data in Excel spreadsheet is to be converted to Access and delivered to Caltrans. (PPRC SPE 3.2.4) • **Development of an Empirical-Mechanistic Model of Overlay Crack Progression Using Data from the Washington State PMS Database.** Asphalt crack propagation models are being developed from WSDOT PMS data. Checking accuracy of cracking models (initiation and progression). Preliminary estimates of preservation treatment performance from Caltrans PMS data being developed. (PPRC SPE 3.2.5) • **Verification of Asphalt Concrete Long-Life Pavement Strategies, - Crack, Seat and Overlay Performance.** Initial estimate made from Caltrans PMS data. Crack initiation and roughness models developed using WSDOT PMS data. Identified key variables needed for PMS. (PPRC SPE 4.5). • **Studies to Support Implementation of Enterprise Pavement Management System.** UCPRC will work with Caltrans SPPM and IT to: - Advise on existing structure data elements, construction as-built data elements, condition survey data collection needs and equipment/analysis systems; - Organize pilots with Caltrans and consultants including GPR, automated condition survey, as-built data gathering, and testing database; - Develop pavement deterioration models. These models, and knowledge of the current state of the pavements, enable quantitative comparison of pavement improvement strategies. (PRC SPE 3.3) • **Version 2 of the UCPRC Manual for Caltrans Life Cycle Cost Analysis.** Develop Life Cycle Cost Analysis and data; develop analysis framework to optimize investment at network level (PPRC SPE 4.15). Refinements to 4.15 have been added (nearly complete). A new element (PRC SPE 4.22) has been added to improve the first version of the manual to provide more accurate maintenance and rehab schedules and cost data, and to improve calculations and table look-ups. **Related work:** • **Pavement Performance Evaluation Phase II** (PPEII) project will contribute test section data for future EPMS and Project Manager will assist with database design issues. PPEII is nearly complete with some additional data analyses to be completed in 2007. • **SPR-3 (074) - State Pavement Technology Consortium** (4-State consortium with WA, CA, MN, TX) A series of project meetings focused on sharing technical information, identifying critical issues of mutual interest, developing plans for joint research and testing, and education.	**Status:** • Incentive / disincentive specification was developed and put in use in 2005. One year of data (2003) was analyzed and a protocol needs to be developed so that researchers can have access to smoothness data. • **Comparison and Verification of Equipment.** Comparisons among manual, retrofitted, and computerized road profiligraphs and bridge profiligraphs were made. Verification among different inertial profilers from different manufacturers was made. • **In-House Research Support. Data** from different contracts were collected and analyzed to develop the incentive and disincentive specification in 2003. The Incentive / disincentive specification was developed and put in use in 2005 for HMA pavement. • **Construction Acceptance - Caltrans In-House Study.** Inertial profiler and walking profilers were purchased at the end of 2006/2007 fiscal year. The equipment will be installed in late July under contract. • **Surface Characteristics Pavement Preservation Task Group (PPTG)** has been established. **UCPRC Work:** • **Investigation of Improved Open Graded Mix Designs.** IRI is being measured on OGAC, RAC-O, RAC-G, and DGAC sections over two years. This study ill provide smoothness data for a set of each pavement type with ages of 0 to 10 years. (PPRC SPE 4.16) • Provide pavement smoothness advice on the comparison and verification of equipment study. (PPRC SPE 2.3) **Related work:** • Others (within Caltrans and outside of Caltrans working at the national level-NCHRP) are conducting research and testing that may provide data to help address bench marking and referencing profile equipment.	**Status:** • Various industry/CT groups have been established for pavement preservation issues under Pavement Preservation Task Group (PPTG) umbrella. • A Pavement Preservation Center has been set up at CSU, Chico and will do tech transfer from research and coordinate with other PP work being conducted by Caltrans. UCPRC will coordinate with CSU Chico and PPTG. **UCPRC Work:** • **Development of Guidelines for Effective Maintenance Treatment Evaluation Test Sections.** A Pavement Preservation Studies Technical Advisory Guide (PPSTAG) was developed for conducting field and laboratory studies. (PPRC SPE 3.2.9) • **Documentation of Pavement Performance Data for Pavement Preservation Strategies and Evaluation of Cost-Effectiveness of such Strategies.** Cost comparison of different preservation treatments based on preliminary estimates of performance from Caltrans PMS data. (PPRC SPE 3.2.5) • **Dowel Bar Retrofit of Rigid Pavements.** This study provided estimates of life, compared with non-doweled pavements. Dowel bar types and designs were compared under HVS traffic. (PPRC SPE 4.8) • **HVS Project: Extended Life Benefits of Pavement Preservation (PP) Treatments.** Need to know the cost-effective service life of various PP treatments. Goals of this project are: compare effectiveness of various treatments in terms of life extension under slow heavy loads. Results help with recommendations for: effectiveness of PP treatments in extending cracking life; mix design of rubberized thin overlays; aggregate seal coat design for bleeding; and timing of PP treatment. (Tied to PPSC Obj. #2, Smoothness, evaluating smoother, more durable pavement surfaces and PPSC Obj. **#8,** Recycling, rubber pavements will be included). (PPRC SPE 4.19) • Continue assisting PPTG for pavement preservation. (PPRC SPE 2.3) **Related Work:** • **Micro-Surfacing/Slurry Seal Mix Design Pooled Fund.** The goal of this research is the development of a rational mix design procedure, guidelines, and specifications. Phase 2, which provides the test parameters for mixing time and performance, will be completed. Pilot projects will be established and a comparison of the new mix design procedure and the ISSA procedure will be evaluated. • **Using Dynamic Friction Tester and Circular Texture Meter to Evaluate Skid resistance for Construction Acceptance.** This implementation project will compare friction test methods against CTM 342 test.	**Status:** • An initial roadmap and approach to understanding sources of noise has been completed in a cooperative effort between Caltrans and UCPRC (Work Plan for: "Investigation of Noise, Durability, Permeability and Friction Performance Trends for Asphaltic Pavement Surface Types", 20 June 2005). This road map is being reviewed by FHWA as a Quiet Pavement Research plan. In the meanwhile testing is being performed by DEA and the UCPRC following the plan. • ARA is conducting a separate research work on PCC pavement. • Danish Research Institute (DRI) will collaborate with Caltrans to look into the performance of the existing mix design with time. • PST worked with UCPRC and developed a Quiet Pavement Research Roadmap for FHWA in collaboration with DRI and three other HQ units (Design, METS and Environmental). It addresses three key areas: what we need to know, what we do know, and what we need to do. Schedule has short and long-term research. **UCPRC Work:** • **Quieter, Smoother, More Durable Pavement Surfaces.** Testing at DEA sites and 45 other sites around state noise, smoothness and condition for open-graded and other asphalt surfaces and relating to material properties, traffic and climate; developing performance models; relating sound absorption to noise; delivering database; assisting CT with FHWA discussions. Have developed CT controlled on-board sound intensity vehicle. UCPRC on QPR submitted the first year report on HMA. The purpose is to measure how noise characteristics in HMA pavements performed with age. (PPRC SPE 4.16) **Related Work:** • Caltrans Division of Environmental Analysis is conducting wayside measurements and contracting on-board sound intensity tests on same sites being tested by UCPRC. • Work similar to that of UCPRC will be conducted by METS contractor on rigid pavements. • FHWA contracted TRANSTEC to measure different pavement noise performance nationwide.	**Status:** • A software application (CA4PRS) has been developed by UCPRC to determine optimum construction scenarios that result in minimal impacts on the traveling public has been developed and demonstrated. **UCPRC Work:** • **Calibration of HiperPav for California Conditions.** Hiperpav is FHWA software for analysis of early-age PCC cracking. A comprehensive review was completed and 4 projects were instrumented and analyzed. (PPRC SPE 3.1.1) • **Evaluation of Concrete Maturity Meters.** Concrete maturity testing to reduce CT field beam testing is completed. (PPRC SPE 3.1.2) • **Development of Rehabilitation Construction Productivity Analysis Products.** New improved versions 2.0 and 2.5 of CA4PRS software are being developed by UCPRC through SPTC fund (WSDOT lead state). Version 2.0 will include traffic delay and road user costs. Version 2.5 will include widening and interchange modules. (PPRC SPE 4.6) • **Development of New Asphalt Concrete QC/QA Pay Factor Tables.** QC/QA pay factors based on performance was developed by a comparison with field performance of 10-year old QC/QA asphalt overlays by CT/industry task group. Final repost is being developed. (PPRC SPE 3.1.5) • **A Framework for Implementing Innovative Contracting Methods for Transportation Infrastructure Rehabilitation/Reconstruction.** Case study of chip seal warranty (District 11) is completed. Analysis method for considering whether to use warranty is being developed. (PPRC SPE 4.14) • ***HVS Project:* Performance of Warm Asphalt and Low-Energy Mixes.** These mixes may potentially reduce energy consumption and emissions. Goals of this project are: comparison of short-term risk of early failure (rutting and moisture damage) between control and warm asphalt mixes for HMA and RAC-G; comparison of rutting and moisture damage risk between different warm products and processes; pilot assessment of warm asphalt construction issues; pilot measurement of differences in emissions and energy use; and recommendations for pilot implementation of warm asphalt. (PPRC SPE 4.18) **Related Work:** • Computer-Based Pavement Tools (TPF-5(090) has been evaluating software through SPTC, since 2004. Objective is to develop and use computer-based pavement tools. Examples include: - HMA View Database - Interactive Pavement Training DVD - Superpave Laboratory - Computer Simulations - Distance Learning - Computation Software (EverFe, EverFlex)	**Status:** • Caltrans has decided to move to ME design methods (Caltrans Issue Memo, Jan 2005). • First versions of ME software applications have been developed by AASHTO (NCHRP 1-37a) and by UCPRC (CalME). • Bench testing including sensitivity analysis has been accomplished. Additional testing on both is ongoing & will be completed in 2007. • NCHRP periodically sending improved versions of software (Ver 1.0 expected 2007). • Data needs, changes to specs, tests, processes and simple design tools being developed as part of ME Work Plan developed by CT Task Group and UCPRC (updated July 2006). **UCPRC Work:** • **Development of the First Version of a Mechanistic-Empirical Pavement Rehabilitation, Reconstruction and New Pavement Design Procedure for Rigid and Flexible Pavements.** Evaluate NCHRP software; develop flexible models; develop traffic (WIM), climate and materials databases, seasonal adjustments; develop flexible (CalME) and rigid (RadiCal) pavement design models/software; calibrate all models with field data; develop simple design tools; assist with implementation. (PPRC SPE 4.1) - NCHRP 1-37a: Sensitivity analysis is run for both rigid (JPCP) and flexible. Version 1.0 of the NCHRP 1-37A will be used with the field calibration to develop the catalog of rigid pavement within this fiscal year. - Backcalculation: Calback version 1.0 will be released by this fiscal year. - CalME: Start evaluating the software in the CTWG. Perform field calibration using MNRoad and NCAT data then will do the sensitivity analysis, at the same time start running the case studies. - RadiCal: Field calibration will be done by the end of this fiscal year. • **Use of the Dynamic Cone Penetrometer (DCP) for Maintenance, Rehabilitation and Reconstruction Site Evaluation.** Investigate relation between Dynamic Cone Penetrometer (DCP) and R-value results. (PPRC SPE 3.1.3) **Related Work:** • CT/UCPRC working with other states in SPTC ME Task Group to evaluate NCHRP, UCPRC and other state models, develop recommendations for AASHTO. • **Pavement Performance Evaluation, Phase II.** Test section data will be used to calibrate ME models.	**Status:** • Caltrans/UCPRC have developed and used new Long Life pavement reconstruction designs and specifications. The construction projects completed are being monitored to determine the effectiveness of the specifications and design. **UCPRC Work:** • **Quality Assurance Laboratory Testing for AC Long Life Pavement Mix Designs, I710 (PPRC SPE 3.1.4) and I-710 Phase 2 Support (PPRC SPE 3.2.11).** Developed structural section and mix designs, QA lab testing, long-term monitoring and evaluation for Phase 1 LA-710 rehabilitation (southern half); Updated lab performance test specification, assisted with pre-bid for Phase 2 LA-710 (northern half). • **Evaluation of Rigid Pavement Long-Life Pavement Rehabilitation Strategies (LLPRS Rigid), HVS Goal 4.** Evaluated long life pavement rehabilitation strategies for rigid pavements, evaluated structural design options, assessed durability of fast-setting hydraulic cement concrete (ASR, sulfate attack, fatigue, strength, stiffness, shrinkage); analyze effects of construction and mix design on durability and structural performance. (PPRC SPE 4.2) • **Verification of Asphalt Concrete Long-Life Pavement Strategies, HVS Goal 6.** Verified asphalt concrete long life pavement strategies, HVS testing of AC long life crack, seat and overlay design for rutting and reflection cracking. (PPRC SPE 4.7) • **Dowel Bar Retrofit of Rigid Pavements, HVS Goal 7.** Evaluating the durability of metal and fiber reinforced polymer dowels for new pavement and retrofit. (PPRC SPE 4.8) • **Investigation of Asphalt Concrete Moisture Damage, HVS Goal 8.** Developed field identification tools, performed state-wide investigation of extent and causes, laboratory investigation of risks and mitigation measures. (PPRC SPE 4.9) • **Development of Integrated Pavement Strategy Decision Support System (incl. Life Cycle Cost Analysis).** Analyzed pavement and non-pavement costs in LLPRS projects to date; Re-analyzed Long Life Pavement project criteria. (PPRC SPE 4.15) • **HVS testing pre-cast PCC panels in District 8.** Performed HVS testing of pre-cast concrete slabs as possible long life strategy for I-15 Phase 2 rehabilitation. Slabs performed well as long as constructed properly. D8 is looking for a pilot site (Note: was 2.3 sub A). (PPRC SPE 4.17) • **100-Year Concrete Pavements.** The goals of this project are to identify new concrete pavement design and construction concepts that can extend pavement life to 100 years and where this may be cost effective. The project will address candidate project locations, traffic projections, construction schedules, and life cycles costs. Tasks identified above follow a detailed Caltrans work plan. (Under PPSC Obj. #1, gap analysis of life cycle accounting for environmental effects). (PPRC SPE 4.21) **Related Work:** • PATH Innovative Topic: A Low-Cost Wireless MeMS System for Measuring (XB09) Weight In Motion Stations (WIMS) help identify overloaded trucks. Project will assess potential of using MeMS as a low cost WIMS detector. If successful this project will use the most effective WIMS technology to reduce the degree of pavement deterioration caused by overloaded trucks.	**Status:** • Asphalt concrete using recycled waste tires has been used by CT for more than 20 years. Half thickness overlay design was verified by UCPRC in 1990s. There is a recent legislative mandate to use more recycled tires. There are opportunities to use them in additional asphalt products. • Deep in-situ recycling pilot projects using recycled asphalt pavement as unbound base and as foamed asphalt stabilized base have been constructed in several districts over the past 5 years. • Building waste and crushed PCC pavement have been used in unbound bases in various proportions for past 10 years. **UCPRC Work:** • **Pulverization – Deep In-Situ Recycling (DISR) Using Recycled AC as Unbound Base: field and laboratory testing.** This study is evaluating the use of pulverization of asphalt pavement as an unbound base. The evaluation includes construction, long-term monitoring, field and laboratory testing, development of design and construction guidelines, and LCC information. (PPRC SPE 2.4.2) • **Development of Improved Rehabilitation Designs for Reflection Cracking.** This study compares the performance of different asphalt mix types containing recycled tire rubber and polymers by HVS and laboratory testing. (PPRC SPE 4.10) • **Guidelines of Deep in-Situ Recycling (DISR) of Cracked Asphalt Concrete as Stabilized or Unstabilized Bases.** This study is evaluating recycling with foamed asphalt by assessing field pilot projects and performing laboratory, field and HVS testing to develop mix design, structural design and construction guidelines. (PPRC SPE 4.12)
Future Research – What else is needed	**Future Direction:** Existing research involving work on the development of an enterprise-wide PMS needs to continue. • **Enterprise Pavement Management System (EPMS)** Need to develop an EPMS within the Department. This should be done by building on the results of the first generation PMS and using a refinement of the Draft E-PMS Master Plan prepared by R&G Associates in FY 06/07. **UCPRC work-- 08/09:** • **Studies to Support Implementation of Enterprise Pavement Management System.** Work will continue on developing pavement deterioration models and data mining tools. (PRC SPE 3.3).	**Future Direction:** • **Construction.** Evaluate current processes and equipment for ways to improve and obtain smoother pavements. Upon obtaining data from roadway profilographs, data from inertial profilers will be collected. A comparison between the contract roadway profilograph and inertial profiler will be made for contract acceptance. Using the inertial profiler the Profile Index and IRI can be calculated. The aim is to move from PI to IRI for the entire life of the pavement. • **Preservation.** Evaluate pavement preservation and rehabilitation treatments for smoothness. • **ME Design.** Develop an improved approach to measuring and understanding of the dynamics of smoothness throughout the entire life cycle (design, construction, use and maintenance) of pavements and structures. • **Specification.** Evaluate the efficacy of existing and new test methods, testing equipment, construction and maintenance equipment, QC and performance specifications, and maintenance applications. • **Vehicle-Pavement Interactions.** Understand interaction of truck dynamics & pavement performance. **Other UCPRC Proposed Work:** • **Thermally Insulated Concrete Pavement.** Asphalt overlays on intact PCC pavement, reduce thermal stresses, noise, roughness (pooled fund). • **Develop Improved Smoothness Pay Factor.** Based on performance models of IRI, truck dynamics and passenger and freight reaction, freight damage. **Related proposed PPRC work listed under other PPSC Objectives:** • Impact of Pavement Preservation Treatments on Smoothness and	**Future Direction:** • A PMS is being developed. Populating the underlying database will begin as soon as a database is established and will allow for creation of pavement prediction models. These models will provide the ability to determine when pavement preservation (PP), rehab or reconstruction is needed. Preliminary models from UCPRC research will be used. **New UCPRC work--begin 08/09:** • ***HVS Project:* Extended Life Benefits of Pavement Preservation (PP) Treatments.** Work will continue on evaluating the performance of PP treatments. (PPRC SPE 4.19) **Other UCPRC Proposed Work:** • Evaluate alternative chip seal design methods. • Measure performance of current PP treatments based on Caltrans PMS and test sections; determine best practice under various conditions. • Measure impact of PP on smoothness and noise; determine best practice for different treatment selection criteria. • Evaluate appropriate friction numbers for various vehicle speeds. • Continue to work with the PP Center in Chico on implementation of PP in Caltrans.	**Future Direction:** A variety of basic and applied research projects will address: - Methods of measuring. - Different materials. - Various physical aspects of the highway infrastructure. - Various construction and maintenance methods and applications. - How quiet pavements perform and a determination of associated life cycle costs. • Based on the research work done by UCPRC and Danish Research Institute a new mix design to reduce the noise without affecting durability, performance, and safety will be considered. **UCPRC work-- 08/09:** • **Quieter, Smoother, More Durable Pavement Surfaces.** Continue ongoing project to monitor noise, pavement smoothness, condition in long-term study required by FHWA (started 2005). Compare results with others incl. Denmark and NCAT. Study mix designs that have better noise reduction and durability over time. Evaluate PP treatments for noise reduction. Long-term performance of asphalt sections incl. life of noise reduction. New mix designs with better performance. Documentation of mix designs, material specs, and prediction of field noise performance. Better mix designs for noise and durability of current Caltrans mixes. Side-by-side comparison of PP treatments for asphalt and concrete. Develop recommendations for best practice. (Under PPSC Objectives 1, 2, and 3) **Other UCPRC Proposed Work:** • HVS testing of OG mixes for permeability performance. • Related proposed PPRC work listed under other PPSC Obj: - Thermally insulated concrete pavement. (Under Obj. #2) - Impact of PP Treatments on Smoothness and Noise. (Under Obj.	**Future Direction:** • CA4PRS software has been successfully demonstrated and training in some Districts has been provided. More is scheduled. Implementation nationally is proceeding. It is not clear if there are problems preventing full implementation. • Laws and policies effecting lane closures and construction activities need to be evaluated for potential impacts that slow construction. • Surveying other transportation organizations for state-of-the art and cutting edge construction methods. Developing new algorithms and software applications for analyzing construction processes, materials, and effects on traffic delay & life cycle cost. **UCPRC work-- 08/09:** • ***HVS Project:* Performance of Warm Asphalt and Low-Energy Mixes.** These mixes may potentially reduce energy consumption and emissions. Goals of this project are: comparison of short-term risk of early failure (rutting and moisture damage) between control and warm asphalt mixes for HMA and RAC-G; comparison of rutting and moisture damage risk between different warm products and processes; pilot assessment of warm asphalt construction issues; pilot measurement of differences in emissions and energy use; and recommendations for pilot implementation of warm asphalt. **Other UCPRC Proposed Work:** • Warm mix asphalt laboratory and field evaluation. (DD) • Dowel Bar Retrofit early opening HVS testing. (I) • Fiber reinforced concrete slab replacement HVS testing. (K) • Use of stiffness instead of relative density for compaction of unbound layers. (U)	**Future Direction:** Develop and use (ME) Pavement Design methods – complete evaluation of AASHTO and other models and software applications: Most issues related to ME have been addressed at the National level (AASHTO/NCHRP 1-37a) and by UCPRC, except how to integrate software for design, analysis, and prediction into an enterprise-wide PMS. • Calibration of ME for California conditions needs to be completed. • Comparison between MEPDG and CalME (expected early 2008; by July 2008 to decide between CalME and MEPDG). • Data needs, changes to specs, tests, processes and simple design tools to be developed as part of ME Work Plan developed by CT Task Group and UCPRC. • Develop asphalt overlay reflection cracking models; calibrate models with HVS data (PPRC SPE 4.10). **UCPRC work-- 07/08:** • **Caltrans Mechanistic-Empirical (ME) Design – Phase 2 Implementation.** Continue ongoing project to implement mechanistic (theory based) design approach that Caltrans decided to adopt in 2005 Issue Memo. This project will: update and show results of field calibration of MEPDG (Mechanistic-Empirical Pavement Design Guide) and CalME software; update JPCP catalog; identify effects of changes in MEPDG versions; produce a simplified tool for flexible pavement design based on ME; summarize a comparison of results between MEPDG and CalME, how they differ from current practice for both new and rehab; produce next version of CalME; and produce a library of ME inputs for typical Caltrans materials and relationships to simple test properties. **Other UCPRC Proposed Work:** • Pervious pavement HVS testing (Caltrans Division of Environmental Analysis Objective). • Thermally insulated concrete pavement. (Under Obj.#2)	**Future Direction:** • Knowledge gained (including performance, behavior, mixes, materials, and techniques) from - Caltrans experience, - HVS testing by UCPRC, and - Experience of others needs to be applied to new designs, specifications, test methods, and processes. • New M-E pavement design procedures need to be used to help develop tools for Long Life Pavements. • New Life Cycle Cost Analysis procedures need to be used to identify where Long Life Pavement is most cost-effective. **UCPRC work-- 08/09:** • **100-Year Concrete Pavements.** Adjust project activities and modify Caltrans work plan if directed. (Under PPSC Obj. #1, gap analysis of life cycle accounting for environmental effects) **Other UCPRC Proposed Work:** • Hot mix design methods for heavy duty pavements including rubber and modified binders. Lab work, potentially followed by HVS testing. Baseline current mix design, evaluate alternative mixes and design approaches, review of fundamental models, recommend mix design procedure. • Moisture sensitivity, mitigation verification HVS testing. • Pavement Design for Dedicated Truck Lanes. Truck only designs (pavement, safety, freight throughput, smoothness, damage to goods, check TxDOT, inclusion of rail). • Use of Dynamic Pre-Compaction for Rehabilitation Projects. • Extended life PCC designs (CRC, JPC, pre-cast). • Elliptical dowels bars. • Related proposed PPRC work listed under other PPSC Objectives: - Thermally insulated concrete pavement. (Under Obj. #2)	**Future Direction:** Quantify, evaluate, promote, and improve high quality pavement recycling techniques (both hot and/or cold) that have been developed by other organizations and build on the experience developed by Caltrans over the past several years. Research is needed on: • The variability of pavement materials and their properties along with the actual impact to recycled products. • Incentives for recycling to change industry attitudes towards recycling. • The possibilities of recycling rigid pavements including CRCP if adopted. • Best methods. • Generally more and varied pilots are needed with analyses capabilities in an E-PMS. • Evaluating designs with varying quality materials. **Other UCPRC Proposed Work:** • HVS testing of alternative base materials, e.g. crusher fines, rubber chips, building waste, etc. (E) • Deep In-Situ Recycling with Foamed Asphalt Comparison of Construction Methods HVS Testing. • Related proposed PPRC work listed under other PPSC Objectives: - Hot mix design methods for heavy duty pavements and rubber and modified binders. Lab work, potentially followed by HVS testing. Baseline current mix design, evaluate alternative mixes and design approaches, review of fundamental models, recommend mix design procedure. (Under PPSC Obj. #7) - Use of Dynamic Pre-Compaction for Rehabilitation Projects. (Under PPSC Obj. #7)
Anticipated changes to business practices	• An E-PMS will require changes in data collection and analysis (amount & capabilities), particularly for as-built maintenance and rehabilitation data and pavement condition survey. • Maintenance of the E-PMS and related integrated transportation information systems will require additional resources. • Will require automated data collection capabilities to populate the E-PMS.	• New testing equipment may have to be procured. Additional resources to maintain, calibrate, and use the testing equipment will be required. • May require adjustments in construction pay factors.	• Maintenance (HQ & Districts) will have to significantly enhance pavement preservation programs in terms of training and tracking of the use of new pavement guidelines and techniques using the E-PMS. • Best practice for treatment selection and timing for different conditions will be determined from current and future research.	• Environmental and Research Divisions will conduct/manage research over the next several years to develop new design, construction, and maintenance approaches to quiet pavements. • Policy decisions will be required.	• The CA4PRS (and possible anticipated future applications) have made it possible to determine optimal construction work schedules in a fraction of the time it takes without the software. • Evaluations of construction scenarios as part of planning. • Changes in construction processes/inspections.	• A percentage of Caltrans engineers will be trained in the use of the ME software for designing and analyzing pavements. When ME methodology is adapted as the routine design and analysis there should be minimal impact to the Department. • New Design Manuals will be based on ME.	• Proven and established, long life pavement designs and construction practices will significantly reduce the annual amount of reconstruction and rehabilitation and the impact on the traveling public.	• High quality pavement recycling will be improvedover several years. This requires training contractor and inspection personnel.